Forest Entomology in Yellowstone National Park, 1923–1957: A Time of Discovery and Learning to Let Live

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For several decades after the creation of Yellowstone National Park in 1872, protection of its biological and other resources was haphazard. For example, elk and bison were exploited to near extinction, prompting aggressive protection of them, which included extermination of the native gray wolf from the park. In those years, tourists were not discouraged from handing out tidbits to bears or even gazing into Old Faithful between eruptions (Fig. 1). Such experiences and the advancement of scientific knowledge have resulted in a more passive management policy, wherein disruptive human influences are reduced in favor of an environment in which natural processes are allowed to run their course. Less well known, however, is the turbulent history of forest-inhabiting insects in the park that began in 1922 with the discovery of defoliated Douglas-fir trees in the Blacktail Deer Creek drainage. This account describes that occurrence and subsequent outbreaks, particularly of defoliators and bark beetles; the circumstances responsible for what now seem to have been inappropriate, and futile actions to control them; and the lessons learned.

In Yellowstone National Park (YNP), forest insects such as bark beetles and defoliators have existed with their tree hosts over epochs of time. Nonetheless, these insect species fluctuate in abundance and impact, regulated mainly by weather and availability of suitable tree hosts. Thus, at relatively rare times, an individual species of bark beetle, defoliator, or other phytophagous insect has become so abundant in YNP as to attract human attention.

Such was the case early in 1923, when forest entomologist James C. Evenden was called to the park to investigate defoliation of Douglas-fir, *Pseudotsuga menziesii* (Mirbel) Franco, reported by personnel of the National Park Service, which had been created only 7 years earlier. As other infestations occurred, more and more insect species became known, studied, and described; and efforts were made to control them. In this article, we examine those earlier times with the intention of documenting a neglected part of YNP history and its influence on present-day management philosophy.

Fig. 1. James C. Evenden took these photos in 1923 on his first entomological visit to Yellowstone National Park. His captions are: (A) "Peeking into the machinery of Old Faithful during its hourly rest." (B) "Jesse James on the job." The behaviors seen here, as well as attitudes toward forest insects within the park, have changed through experience gained over time. (Photo A, no. 159; B, no.160)

Much of what we sought to record about the early history of forest entomology in YNP occurred between 1922 and 1934, when the insects involved were discovered and vigorous efforts were made to control them. Infestations and control actions were generally less intense or extensive during the next 20 years. We have however included the aerial spraying during 1953–1957 of the now-banned insecticide, DDT, because it came at the end of an era. James C. Evenden, who was a central figure throughout this period, retired during that time. Soon thereafter, park management philosophy and policy took a friendlier course and more enlightened stance on the natural roles of these miniature, native park fauna[1].

[1] Forest insect management philosophy arose from a 1918 policy statement (Lane 1922) to maintain and protect the forests from "disfigurement . . . unless their destruction (felling and treatment) is necessary to eliminate insect infestations or diseases common to forests . . ." Such policy prevailed until, influenced by the Leopold Committee Report (Leopold et al. 1963), National Park Service policy was revised to acknowledge: "Native forest insects . . . are natural elements of the ecosystem . . . [and] will be allowed to function unimpaired . . ." except under certain conditions (USDI 1970). This policy and philosophy exists today and allows limited use of integrated pest management practices where more active management may be needed (USDI 2001).

The Entomologists

Forest entomology in the northern Rocky Mountains began in January 1909 when Josef Brunner, a native of Bavaria with some forestry training, observed bark beetle-infested lodgepole pines, *Pinus contorta* Douglas var. *latifolia,* in the Little Snowy Mountains, Mont. (Furniss 2003). He wrote to Gifford Pinchot, Chief of the Forest Service, Washington, D.C., asking ". . .the name of the little bug which makes the inner bark of freshly fallen trees . . . its primary breeding place then attacks en masse nearby standing green trees?" Pinchot referred the letter to Andrew D. Hopkins, Chief of Forest Insect Investigations, USDA, Bureau of Entomology. Brunner's continued interest resulted in his being recruited during the following summer by Hopkins to investigate the virtually unknown forest insects of that region.

The next person on the scene was James C. Evenden (1889–1980), a recent forestry graduate of Oregon State Agricultural College, who was hired by Hopkins in October 1914 as an Entomological Ranger at $75 per month and directed to report to Brunner at Missoula, Mont. Evenden had been working as a seasonal fire lookout with the Oregon National Forest (now Mount Hood N.F.) and was scheduled to be furloughed over winter.

Brunner left the Bureau of Entomology in 1917 due to a falling-out with Hopkins. He was succeeded by Evenden, who established his headquarters at Coeur d'Alene, Id. (Fig. 2) and remained there as leader until his retirement in early 1955. Throughout the time period of this article, he was in charge of the laboratory and was responsible for forest insect damage surveys and supervision of control projects in YNP. Following Evenden's retirement, the forest insect laboratory was closed, and the personnel were transferred to a Forest Service facility in Missoula. Other people involved in this account who were employed at the Coeur d'Alene Laboratory were Tom T. Terrell (1904–1985) and Reginald E. Balch (1894–1994).

Fig. 2. J. C. Evenden in front of the building in which the Coeur d'Alene, ID, Forest Insect Laboratory was located during 1919–1923. (Photo no. 92).

Tom Terrell, a high school graduate, was launched unwittingly into a career in forest entomology in 1926 at age 22. He was reporting to work as a fire guard for the U.S. Forest Service in Montana when, "At Wisdom [Montana], I got on the wrong F.S. truck and ended up at a bark beetle control camp where I met Jim Evenden. Jim thought that I might be a good spotter [locating infested trees to be treated]."

In 1930, Terrell made the first aerial survey of forest insect damage in the northern Rocky Mountains (Fig. 3):

> The first flight of the survey could not be called auspicious; it was to be over Yellowstone National Park from a field at Livingston, Montana. I had maps of the park but nothing for the 65 miles between Livingston and the park. The pilot had a railroad folder that showed a line going straight south to the park. Away we went and got lost in the Absaroka Mountains where we were caught in a violent rainstorm. The plane was a small open-cockpit biplane, the pilot in the rear and me up front. The engine went quiet! Then loud pounding behind me! I was about to dive over the side and pull the ripcord when I discovered that the pilot was pounding on the plane to get my attention. He got it. He wanted to know if I didn't think we ought to go back? He had cut the engine so he could talk to me. I most certainly agreed with him. I was scared stiff. We made it back to the field where Jim Evenden was waiting. By that time the storm was real bad. The pilot taxied the plane up to the fence where we jumped out and with the help of Jim hung onto the plane and the fence to keep the plane on the ground until the storm let up. The pilot was Nick Mammer who later became a famous aviator in the region and one of the first mail and airline pilots in our area (Terrell 1977).

Throughout the years, Terrell was involved in numerous other surveys, both on the ground and in the air, and in various control projects in YNP and adjacent national forests. (Evenden and Terrell spent much time assisting park personnel to deal with forest insect infestations and left a legacy of unpublished reports and photographs on which this article is largely based.)

Reginald Balch was born in England and emigrated to Canada at age 19. Following service during World War I and graduation from Syracuse University, he worked during 1928–1929 as a forest entomologist with the Coeur d'Alene Forest Insect Laboratory. Thereafter, he moved to Fredericton, New Brunswick, where he became officer-in-charge of the Forest Biology Laboratory and attracted much acclaim for his work. During 1929, he worked in southwestern YNP at Bechler River Ranger Station, studying a budworm on lodgepole pine as noted later.

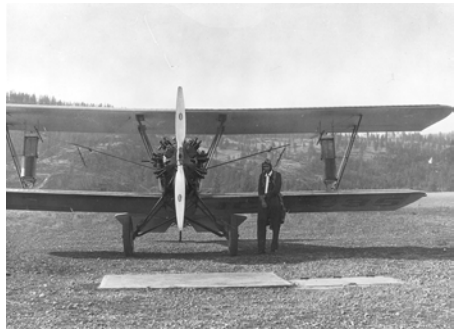

Fig. 3. In 1926, Tom T. Terrell joined Evenden's staff and conducted the first aerial survey of the park in 1930. He is shown here in 1932 beside an open cockpit airplane like that used on his landmark survey that marked the first such use of an aircraft in the northern Rocky Mountains. (Unnumbered photo).

1923, Yellowstone Entomology Begins

Evenden visited YNP on 9–10 June 1923 in response to the park superintendent's report of defoliated trees (Evenden 1923). He observed defoliated Douglas-fir (Fig. 4) and Engelmann spruce, *Picea engelmannii* Parry, at the head of Blacktail Deer Creek and along the south side of the Yellowstone River opposite Hell Roaring Creek.

Examination disclosed only empty pupal cases still clinging to trees from the previous year (unbeknownst to him, at that date the overwintered insects were still tiny larvae, hidden within silken hibernacualae in crevices in the tree stems). The pupal cases looked to him to be those of the eastern spruce budworm[2], an insect unknown in the western United States until this infestation and concurrent ones in Idaho. He returned in early

[2] Having at that time the scientific name, *Cacoecia fumiferana* Clemens. During early years of investigations, the identity of insects encountered was often uncertain because they had not been named and described; or their similarity to known species elsewhere resulted in misidentification. In reviewing the history of Yellowstone entomology, additional complications are presented by intervening taxonomic revisions or instances in which an insect has been described as a different species than had been supposed. For example, the generic name *Cacoecia* underwent several changes and presently is designated *Choristoneura*. Furthermore, the Yellowstone insect was actually a new species and was described subsequently as *Choristoneura occidentalis* Freeman and given the common name western spruce budworm. Henceforth, regarding other species, we show the presently accepted name.

Fig. 4. The first record of forest insect activity in the park began in 1922, when defoliation of Douglas-fir was reported in the Yellowstone River drainage. Evenden visited the area in 1923 and determined that defoliation was caused by a spruce budworm previously unreported in the West. (Photo no. 226).

July to find abundant larvae, now grown in size, devouring new foliage. The suspected identity of the insect was confirmed on his third visit in August when moths were in flight around the afflicted trees.

Evenden speculated in his report on 5 October 1923, that "This epidemic [may] continue for a number of years with a great loss of timber," but that artificial control was not feasible. "Application of poison dusts from airplanes, especially lighter than air machines seems the most possible. However the area is very rough and mountainous and such an undertaking would be more than dangerous." Prophetically, he added: "Furthermore with use of sprays or poison dust in such a manner, great care would need to be exercised to prevent a heavy mortality of animals feeding upon grass and shrubbery throughout the treated region." Such danger to a grazing cow would be realized in 1930, following ground application of lead arsenate to control the budworm near the park's east entrance in Cody Canyon.

Budworms Mar Cody Canyon and Get Dosed with Lead Arsenate, 1929

While the Blacktail Deer Creek infestation was running its course in the north-central corner of YNP, a separate spruce budworm infestation was attracting attention in Cody Canyon, the popular eastern approach to the park. By 1929, alarm was being voiced to officials by the summer home and resort owners, as noted by Evenden (1930a).

> With the spread of this epidemic into the forests noticeable to the layman, public opinion became insistent that something be done to prevent further destruction of these timber stands in order to preserve the beauty and economic value of the region.
>
> The scenic values at stake were evident in the preface of Evenden's report.
>
> The Cody Canyon provides one of the most popular and beautiful entrances to the Yellowstone Park. The beauty of the rugged mountainsides, which rise from the Shoshone River for thousands of feet, depends upon the dense forests of Douglas-fir for a proper setting.

Responding to the insistent call for action by residents of the area, Evenden made the first effort to control the budworm in the West in June 1929, when 300 acres of infested trees were experimentally sprayed with mixtures of lead arsenate and water. Fish oil was added to help the poisonous spray adhere to foliage that would be ingested by feeding larvae. This sort of spray had been effective against larvae of the gypsy moth, *Porthetria dispar* (L.), on deciduous trees in the eastern United States.

Evinrude forest fire pumps were used to apply the spray through 150 ft of hose. Spray solution was mixed by hand in two 55-gal barrels. Trouble was encountered on several counts. The spray only reached a height of 50 ft, whereas some trees were more than 100 ft tall. Even then, the low pressure produced a stream rather than a more desirable mist. According to Evenden, "The effect secured with this equipment could be compared to the washing from a garden hose." Back at the barrels, the ingredients separated readily, ". . .it seemed nearly impossible to keep the mixture properly agitated and the oil from rising to the top."

Evenden concluded, "The outfit could be called 'hay wire' as it was cumbersome, difficult to move, slow of operation, and not at all adapted to the spraying of tall trees. . . An examination of these trees later in the season showed very little beneficial effects of the spray." Nonetheless, he called for another round in 1930: "It is sincerely believed that the seriousness of the problem within the Cody Canyon warrants the institution of another experimental spraying operation on an extensive scale, in an effort to preserve as much of the natural beauty of the region as possible." Besides, ". . .with the makeshift equipment in use [in 1929], it was evident that the tests . . . could not be considered as being adequate or decisive, and that further experiments with proper equipment on a more extensive scale were necessary before final conclusions could be drawn."

Bigger, If Not Better, Efforts to Control Budworms in Cody Canyon, 1930–1932

Fortuitously, better spray equipment lay close at hand in the park, evidently acquired for spraying lodgepole pines infested with other defoliators (needletiers and sawflies) near West Yellowstone. From 13 June to 7

Fig. 5. During 1929–1934, an infestation of western spruce budworm in Cody Canyon, Wyoming, was sprayed heavily with a solution of lead arsenate in an attempt to protect the scenic east entrance to the Park. The project was beset with difficulty. (A) "High-power sprayer" and hose strung across a bridge to reach the Ramsey's dude ranch. (B) Crew at the other end dousing an infested Douglas-fir. In response to the insistence of local inhabitants, thousands of gallons of spray were applied to trees around seven ranches and along the road leading to the Park. (Photo A, no. 713; B, no. 651).

July 1930, the park's "high-power Fitzhenry Gupti sprayer" (Fig. 5A) was used to apply 136,000 gal spray containing 3,864 lb lead arsenate at a cost of $10,000 (Evenden 1931a). The pump delivered 300 psi through 1,500 ft of hose to a height of several hundred feet. Four or more crewmen were needed to wrestle the lengthy hose, sometimes having to cross the Shoshone River to reach the summer homes and resorts.

The spray had to be applied (Fig. 5B) during the short time between opening of buds but before the budworm caterpillars could feed extensively on the developing needles. Crews worked two 8-hr shifts. Evenden was on the scene until 24 June, when he left his field assistant, Vernon Lopp, in charge. During the second shift on 25 June, the tank "stopped up." Lopp "made a check-up on the crews to learn who was missing, as we found someone's underwear in the spray tank" (Lopp 1930).

In his weekly report to Evenden, Lopp continued,

> Tuesday, July 1: Got both sides (of) road from camp west of Holm Lodge, where spraying occurred 24 June [Fig. 6]. Holm management finds it can't feed its cows on lead arsenate and make them thrive. A year-old heifer, one of several that had been turned in to graze on a sprayed area following rain a few days ago, became ill Saturday afternoon and died Monday. . . .Nothing was said about it. I talked with Mrs. Shawfer, and I think they intend to keep their stock away from arsenate from now on.

Looking back, Evenden commented that spraying in 1930, ". . .was intended to be an experimental project," however, ". . .due to the seriousness of the infestation, it quickly developed into a straight control operation with little thought of experimental values." He concluded that ". . .the results were so inconsistent that the operation . . . could hardly be recommended as a method of control for future epidemics" (Evenden 1931a).

However, Evenden's tenacity in the face of discouraging results continued. In 1931, numerous variations of treatment were tested, but none seemed much better, perhaps in part because of the complexity involved, resultant mistakes made by inexperienced field personnel, and the pressure of working against time. Worse, however, for purposes of the tests, nature turned out to be a whimsical place in which to experiment. The budworm population suddenly declined from natural causes, making it difficult to assess treatment effectiveness.

The combination of these problems is evident in Evenden's subsequent report (1932), "It is difficult to measure results as [mistakenly] no larval counts were taken in untreated trees used as checks. Furthermore, . . . as there is so little difference in the injury between the treated and untreated trees, it is even more difficult to weigh the value of these sprays and dusts."

Fig. 6. (A) Spraying lead arsenate on budworm-infested trees at Holm Lodge in Cody Canyon leading to Yellowstone Park, 1934. (B) Holm Lodge, now renamed Crossed Sabres Ranch, as it appeared in 2000. (Photo A, no. 643; B, by authors).

Some lead arsenate was left over from the 1931 project and applied in 1932 to the following dude ranches: "Holm Lodge, Blackwater, Absoroka, Elephant Head, Powell Colony, Ramseys and Artist Colony." Thereafter, the budworm seemed to diminish in importance, apparently due to natural causes. By then, however, more than 260,000 gal of spray containing thousands of pounds of lead arsenate had been applied and reapplied to inhabited areas of Cody Canyon and along its roadsides.

How all that could happen is subtly apparent in the last report we have by Evenden (1933) that is devoted specifically to this outbreak of budworm in Cody Canyon.

> Though this project has rather forcefully demonstrated the ineffectiveness of present methods of control against the spruce budworm it is believed by many (occupants of the area) that the reduction secured from such treatment has been sufficient to preserve the trees around the "Dude Ranches" and resorts for which the protection was especially desired.

Budworm Variant Discovered in Lodgepole Pine at Bechler, 1928

In 1928, Evenden examined lodgepole pines that had been reported to be defoliated by an unknown insect in the Bechler River drainage in the southwest corner of the park, adjacent to Targhee National Forest (Fig. 7A). ". . .and much to the surprise of the writer, the insect was found to be the spruce budworm. . . . this is the first record . . . of this insect . . . adapting itself to a pure stand of pine" (Evenden 1929). He noted, however, that the insect may prove to be a "variety" of the spruce budworm and that "the possibility of pure [lodgepole pine] stands becoming an accepted host of this insect places its economic importance in more serious light than before."

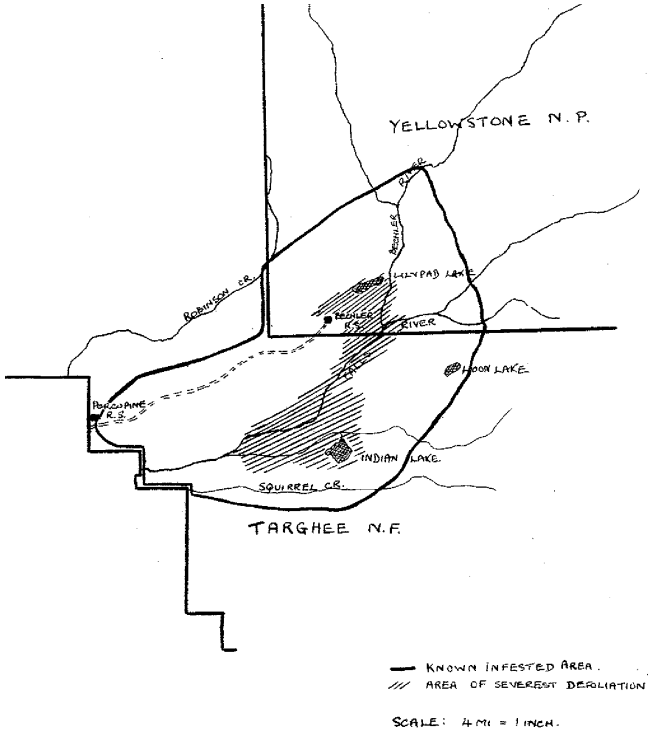

Fig. 7. (A) In 1928, lodgepole pines in southwestern YNP were defoliated by what was thought to be a variant of the spruce budworm. It was described later as the sugar pine tortrix. (B) Map showing extent of the infestation. (Photo A, no. 220; B, Balch 1930).

In 1929, Reginald E. Balch of the Coeur d'Alene Forest Insect Laboratory studied this budworm intensively while stationed at the Bechler Ranger Station. He concluded that it must be a variety of the eastern spruce budworm: *Cacoecia fumiferana* var. *lambertiana* Busck (Balch 1930), known now as a distinct species, the sugar pine tortrix, *Choristoneura lambertiana* (Busck), infesting pines in much of the West.

During that single season, Balch described the insect's life stages, life history and habits, and natural enemies. He also explored a method to representatively sample populations of the insect in trees, mapped the extent of the infestation (Fig. 7B), and determined the effect of defoliation on the annual radial growth and mortality of infested trees. Although this insect was studied later (McGregor 1970), we found no reference there or elsewhere in the literature to Balch's outstanding and historically important study. Balch transferred to Fredericton, New Brunswick, soon afterward, and other matters may have kept him from publishing this work.

After Balch's departure, Evenden (1931b) noted: "Data secured during the past season [1930] would indicate that from 10 to 15 percent of the infested trees . . . are either dead or dying." However, by 1933, the infestation had subsided according to a report by F. T. Johnson of the chief ranger's office (Johnson 1933).

A decrease in the intensity of this infestation in the Bechler River region was noted last year (1932). This year inspections have revealed that the infestation has almost completely disappeared. The lodgepole pine trees formerly attacked now appear unusually healthy and practically no damaged buds could be found.

Again, the resiliency of the natural forest was demonstrating itself—given time.

Needletier and Sawfly Defoliate Lodgepole Pine at West Yellowstone, 1924–1928

H. E. Burke, an employee at the Palo Alto, CA, forest insect laboratory (Furniss and Wickman 1998), worked in YNP during the summers of 1925–1927. He mainly studied two "destructive defoliators" of lodgepole pine: the lodgepole sawfly, *Neodiprion burkei* Middleton (subsequently named after Burke), and the lodgepole needletier, *Argyrotaenia tabulana* Freeman[3] (Burke 1932).

The needletier is a small moth, the caterpillars of which web together current-year needles on which they feed. The female sawfly has a serrated ovipositor for sawing slits in leaves in which to lay its eggs. Its larvae feed on old, rather than current-year, foliage. Thus, the two species of insects acting in concert had a much greater effect on their tree hosts than either would have alone.

[3] Identified at the time by taxonomists to be an eastern U.S. species, *Argyrotaenia pinatubana* Kft. It was described as new by Freeman (1944).

Defoliation caused by these two insects was reported in 1923 by Chief Ranger S. T. Woodring. Evenden visited the area in July 1924 at the request of Superintendent H. M. Albright (Burke 1932). Thereafter, the Park Service sprayed "a strip of timber about 150 ft wide on each side of the first 5 miles of main highway between West Yellowstone and the Madison River bridge" (Fig. 8). The spray formula had been developed in the East for controlling caterpillars of the gypsy moth. It consisted of 25 lb powdered lead arsenate and 1 gal fish oil or raw linseed oil to 400 gal water (Burke 1925).

Spraying continued under Burke's supervision during 1925–1927 along 7.5 miles of this road and some of its lateral highways. He concluded, "spraying will have to be continued each year as long as the epidemic exists because the sprayed areas are re-infested by moths which [fly] from the adjoining unsprayed areas."

Burke (1932) considered two other less restricted methods to deal more effectively with the outbreak that extended over 34,000 acres in YNP and 46,000 acres on the adjacent Madison National Forest (now Gallatin National Forest). One method involved burning the duff beneath trees to destroy chrysalids of the needletier and cocoons of the sawfly, both of which overwinter in litter on the ground. The other method was to apply dust containing lead arsenate by airplane, as had been used in other regions against other defoliating insects. However, fire was deemed to be "ei-

Fig. 8. Spraying lead arsenate on lodgepole pines infested with larvae of needletiers and sawflies along the park highway near West Yellowstone, MT, July 1924. (Photo no. 263)

ther too dangerous when conditions favored burning or ineffective when safe to burn." Aerial dusting was considered to be an undeveloped method of questionable "efficiency" and, besides, it was difficult to obtain an airplane.

During 1925–1926, for which records are available, 120,000 gal spray containing 7,500 lb lead arsenate were applied along roads in the affected areas. Burke estimated that spraying killed about 90% of the insects and that there was no noticeable defoliation of the trees sprayed. Thereafter, the needletier was mentioned periodically in reports, but in the absence of defoliation of old needles by the sawfly, this insect caused little concern.

Curiously, this seems to be the only recorded extensive outbreak of this sawfly in the western United States (Furniss and Carolin 1977). Equally curious to us is that Burke is the only person to have actually published on forest insects in YNP during this historical period (Burke 1932).

"Tourist Disease" and Geysers Add to the Casualties

For a 6-year period beginning in 1923, forest entomologists of the Bureau of Entomology's western stations shared items of mutual interest through a monthly "Western Division Newsletter." While studying the lodgepole pine needletier and sawfly, Burke was called upon to examine trees dying from other causes in the park; and in the October 1925 newsletter, he posted a note (Burke 1925) under the heading: "Geysers cause insect infestation." It read,

> Dying and dead trees are scattered around most of the geyser formations in the Yellowstone National Park. . . secondary insects (contribute to) . . . the death of many of them. At irregular intervals the geysers and hot springs change their course of flow or break out in some new location. If the hot water flows through the timber, the trees are killed . . . until the area looks like a forest graveyard . . . Cloudbursts, landslides, beaver dams, road grades and tourist camps cause similar infestations and areas of dead timber in numerous places in the park.

By 1928, the term "tourist killed" was in vogue to describe the reason why campground trees were susceptible to infestation by "secondary" insects that were incapable of infesting trees in their natural state (Evenden 1929). The term soon became "tourist disease." Evenden advised the park personnel that the underlying cause was

> The duff and humus are removed [by tourist activity] and the soil becomes dry and solid. The roots are exposed and the bark worn from the upper surface. The base peeled and scraped by automobile bumpers and fenders and from . . . these unfavorable conditions the trees soon weakened and are easy prey to the attacks of secondary bark beetles . . .Piling of dirt around the base of trees should be discouraged.

In the following year, he pointed out that relatively few trees were afflicted with this tourist disease but that ". . .as tourist travel becomes heavier and the injury to the trees becomes more apparent, this loss will increase. In a few years, . . . the natural cover of these campgrounds will be seriously depleted . . ." (Evenden 1930b). He appended photographs depicting campground trees that had suffered such abuse (Fig. 9). He also noted, under the heading "Formations," that

> A mile south of the Mud Volcano there is a rather large group of lodgepole pine trees which have been killed by excessive water. A spring or small stream has overflowed its original channel, flooding the area and causing the death of the trees. As the size of the area is increasing each year, it is recommended that the water be confined to a prescribed course.

Besides the campground activity, clearing of trees during an active program of road construction also led to build-up of species of bark beetles, such as the pine engraver, *Ips pini* (Say), that normally are not a problem. This was evident in the 1931 annual forestry report for YNP (Johnson 1931a): "During . . . 1930 an intensive program of road construction was in effect between Mammoth Hot Springs and Madison Junction. Due to the unavoidable injury to the trees along the right of way from blasting, grading, and burning, an unusually large number of [*Ips*] attacked trees [resulted]." During June and July, a five-man crew cut and burned 2,000 such trees.

Fig. 9. "Tourist disease"—compaction of soil and damage to roots by Park visitors, shown here—often led to infestation by "secondary" bark-infesting insects that were not involved in killing trees in the natural forest. (Photo no. 712).

Even when road construction was not involved, roadside pine trees still became infested, sometimes after being downed or stressed by the elements. During 1934, a crew treated 10,244 such trees (Fig. 10) within 150 ft of the road for a distance of 18 miles between Obsidian Cliff and Madison Junction (Barrows and Baggley 1934).

"Yellowstone Park Barkbeetle Control Project"—A Sheep in Wolf's Clothing, 1931

In the late 1920s, while the needletier and sawfly diminished in importance, a greater specter—the mountain pine beetle, *Dendroctonus ponderosae* Hopkins—was building to astounding abundance in the lodgepole pine forests west of the park. In 1931, the perceived threat to the park's vast stretches of scenic pine forests posed by the advancing army of beetles led to the so-called "Yellowstone Park Barkbeetle [*sic*] Control Project." although it involved little actual control work within the park. To understand the circumstances and motive for this incongruity requires backtracking to earlier days.

According to Evenden (1944), the first record of the mountain pine beetle (though misidentified at the time) appeared in a 1898 report of the U.S. Geological Survey (Ayers 1898). Ayers had observed extensive stands of infested western white pine, *Pinus monticola* Douglas, in the North Fork Flathead River drainage, Montana. No further record of this insect was known in the region until 1909, when Josef Brunner was appointed special agent in Montana. From then on, accounts of mountain pine beetle infestations in drainages of the Flathead, Swan, and Clearwater Rivers, Montana were frequent (Evenden 1944).

By 1926, these infestations were becoming more severe and appeared to be migrating southward and eastward. During 1927–1936, the mountain pine beetle killed almost 58 million lodgepole pines surrounding the Big Hole Basin, Beaverhead National Forest, a mere 100 miles from the park (Evenden and Gibson 1940). The notion that this beetle was flying into new stands rather than developing in place within them was not easily proven. In an attempt to demonstrate the flight capacity of these beetles, Tom Terrell, who had a flair for invention, flew Weather Bureau kites (Fig. 11) tethered with piano wire and equipped with ingenious traps to catch any beetles flying across miles of open terrain in the Big Hole Basin. However, because during 29-1/2 hours of trapping he caught only two bark beetles, neither of which was a mountain pine beetle, the question remained (Terrell 1934).

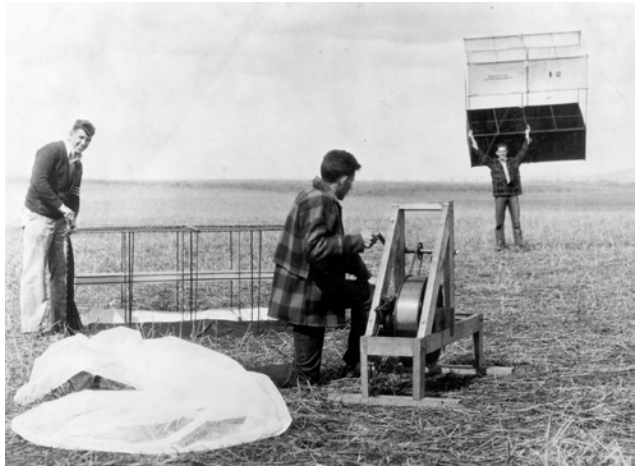

Fig. 11. Tom Terrell (kneeling) at winch used to raise a U.S. Weather Bureau kite containing a net (lower left) to 8,000 ft above ground during study of mountain pine beetle flight in 1933. (Photo no. 768).

Fig. 10. (A) Area infested with pine engraver beetles near Norris Junction before control work was started. Fallen and standing trees contained beetle broods. (B) The same area after control work was completed. (Barrows and Baggley 1934).

Fig. 12. J. C. Evenden (shown on right at a control camp in 1927) proposed a huge operation under the title "Yellowstone Barkbeetle Control Project." (Photo no. 352).

Whatever the case, increasingly stronger efforts were made to control the advancement of this enormous outbreak, and Evenden was in the thick of it (Fig. 12). The beetles raged on. During 1928, more than 300,000 lodgepole pines were infested in the Beaverhead N.F. alone; and 30,000 were tallied for the first time farther south on the Targhee N.F., Idaho, bordering the park. The Targhee infestation increased to 119,000 trees in 1931.

At this point, Evenden became convinced that, indeed, the beetles were winging their way southward and eastward with Yellowstone Park standing in their path. Increased amounts of money would be required to stop them. Evenden hit upon an idea calculated to gain financial support; he called it the "Yellowstone Park Barkbeetle Control Project" (Evenden 1931c).

> Perhaps a word of explanation as to the writer's selection of the title [for the project] is necessary. Though in the past all steps of this project which started in 1926 have been considered under local names (e.g., Big Hole Basin), it would seem best at this time, inasmuch as the protection of the scenic value of the Yellowstone is their primary objective, to consider them under the title given.

However, the circumstance of vast stands of susceptible lodgepole pine stressed by droughty weather made the battle one-sided in favor of the beetles. In 1934, L. A. Strong, chief of the Bureau of Entomology and Plant Quarantine, and representatives of the Secretary of Agriculture visited the Beaverhead N.F. and expressed concern about the threat to the scenic pine stands of YNP. As a result, all adjacent national forests were surveyed, with the finding that 1.3 million trees were now infested, requiring $4.5 million to treat them (Evenden 1944). According to Evenden,

> Details of the situation were taken to Washington, D.C., for review and consideration by officers of the Departments of Agriculture and Interior. This project, which had by then become known as the Yellowstone Barkbeetle Control Project, holds the distinction of being, up until that time at least, the only bark beetle control project to be submitted to the President of the United States for final approval.

The project was not approved, however, apparently in part because of problems involving logistics and shortage of time. Unknowingly, this decision was fortuitous, as natural forces, primarily severe winter temperatures, controlled the outbreak. As Evenden reflected later (1944): "The wisdom of this action, which could not have been foreseen at that time rests in the subsequent cessation of the outbreak with but little damage to the lodgepole pine forests of the Yellowstone National Park." Thus, the sheep was sheared of its wolfish cloak, and the forest west of the park began its cycle of renewal. It is likely to be visited again by beetles at a future time unless fire or harvesting alters the development of dense, mature stands of lodgepole pine on which outbreaks of the beetle depend.

Bechler River Mountain Pine Beetle Control Project, 1931

During the fall of 1930, a field crew gathering data for a forest type map of the park discovered a mountain pine beetle infestation in lodgepole pine in the Bechler District (Johnson 1931b). By then, park officials were highly sensitized to the perceived danger to the park's extensive forests of lodgepole pine. In his annual forest insect report, Johnson summed it up.

> The heavily infested forest areas . . . particularly southwest of the park present a serious problem and we are taking every precaution in cooperation with the Forest organizations adjoining us to prevent these infestations from entering the park . . . We have learned . . . that by far the largest of their [Targhee N.F.] insect control projects is within several miles of the southwest corner of the park and in one place practically touched the park boundary. They have spent many thousands of dollars combating this infestation which is in an epidemic

Fig. 13. (A) Assistant Chief Ranger Fred T. Johnson was responsible for surveys and control of forest insect infestations in YNP during 1930–1933. (B) Chief Ranger George T. Baggley, seen here near Hellroaring, YNP, 1930, was responsible for instituting and staffing a program to combat outbreaks of forest insects that were seen as blemishing and even threatening to the existence of scenic forests of the park. (C) Ranger Albert T. Bicknell (left), Mrs. Kathryn "Bina" Bicknell, and Ranger McCarty. (D) Forester Maynard Barrows, who succeeded F. T. Johnson in 1934, was in charge of forest insect surveys and control in the park. (Photo A, 9137-3; B, Yell 42917-2; C, 3766/ Yell 34027; D, Yell 42954: from the YNP Archives, Mammoth, WY).

stage and we feel that we cannot afford to hesitate in our control measures in the Bechler region.

Evenden advised that the area be surveyed to determine the need for control. The survey was completed in January, and a control project was begun in the following spring.

Park personnel on this project included most of the prominent forestry-related individuals of this period: Forest Assistant Fred T. Johnson (Fig. 13A) was in charge of the project and "directly responsible" to Chief Ranger George F. Baggley (Fig. 13B). Park Ranger Albert T. Bicknell (Fig. 13C) was selected as camp manager, and Ranger Maynard Barrows (Fig. 13D) and three others were assigned to the project as foremen. Terrell provided technical advice and scouted for additional infestations.

The method used was termed "standing–burning" in which fuel oil was sprayed upward on the truck into the branches and foliage and then ignited. The intensity of the fire was enhanced by pumping additional oil into the crown after ignition (Fig. 14). Some larger trees had to be felled and burned. A total of 2,888 infested lodgepole pine trees were treated between 9 May and 10 July, at which time fire danger had become extreme, and funds were exhausted. Johnson concluded:

> With the splendid cooperation of the Bureau of Entomology and U.S. Forest Service [their Targhee N.F. neighbor] and diligent efforts of the Park Service officers assigned to the project, we believe that the mountain pine beetle infestation in the Bechler River region has, with the exception of a small area, been reduced to normal.

Mt. Washburn Mountain Pine Beetle Control Project, 1933–1934

The mountain pine beetle was first reported infesting whitebark pine, a species adapted to high altitude, in YNP near Dunraven Pass in 1925 (Albright 1925). During 1930, increasing numbers of mature trees were becoming infested and killed in this area. Simultaneously, this pine species also was being killed over extensive areas in the mountains of central Idaho, creating long-lasting "ghost forests" (Ciesla and Furniss 1975). The intensity of white bark pine mortality within YNP resulted in control projects in 1933 and 1934 at Mt. Washburn (Johnson 1933, Barrows and Baggley 1934).

Although 42 infested trees had been felled and burned following discovery of the 1925 infestation, the 1933 project on Mt. Washburn was a far more concerted effort to control mountain pine beetles in whitebark pine, and it met with dismal results. Four Civilian Conservation Corps (CCC) camps had been established in YNP that spring, and word was passed that "the insect control work at Mt. Washburn must be included in the program of the Emergency Conservation work (ECW)" (Johnson 1933). However, infested trees had to be felled and burned to destroy beetle broods before they matured and flew to infest other trees. This left little time for organizing and training the crews. The futility of the operation was evident in Johnson's report.

> It must be admitted here however that because of the late start in beginning this project due to the late arrival of the C.C.C. camps, and heavy snows throughout the infested area, as well as other important factors such as inexperienced labor, lack of sufficient overhead, loss of time through transportation of men to and from work a distance of 8 miles and no work on Saturdays, Sundays, or holidays, and because of the inability to arrange for spike camps, the Mount Washburn mountain pine beetle control project fell far short of being completed. This however is not a direct criticism of the C.C.C. . . .The enrolled men were mostly from New York City, and had not been toughened in to hard steady work with axe or saw . . .Experienced overhead was almost impossible to find due to the large demand throughout this region for trained foresters, and incidentally experienced insect control men on E.C.W. jobs.

CCC crews were used again in 1934, but this time the park also hired 70 men from nearby communities who were accustomed to working under the primitive conditions encountered on site (Barrows and Baggley 1934). As before, the CCC crews commuted daily between the project and the "Canyon Camp" 8 miles away. However, the hired men were located 2 to 2-1/2 miles from the road, either on the east side (Section 13) of Mt. Washburn or at Carnelian Creek on the west side (Section 17/18). They were "rationed by pack string horses from the base camp near the road at Dunraven Camp" (Fig. 15A).

Fig. 14. "Burning-standing" method of mountain pine beetle control. Fuel oil was sprayed upward on the trunk of infested lodgepole pines and ignited to destroy beetle broods in the bark. Bechler Ranger District, YNP. 1931. (Johnson 1931b).

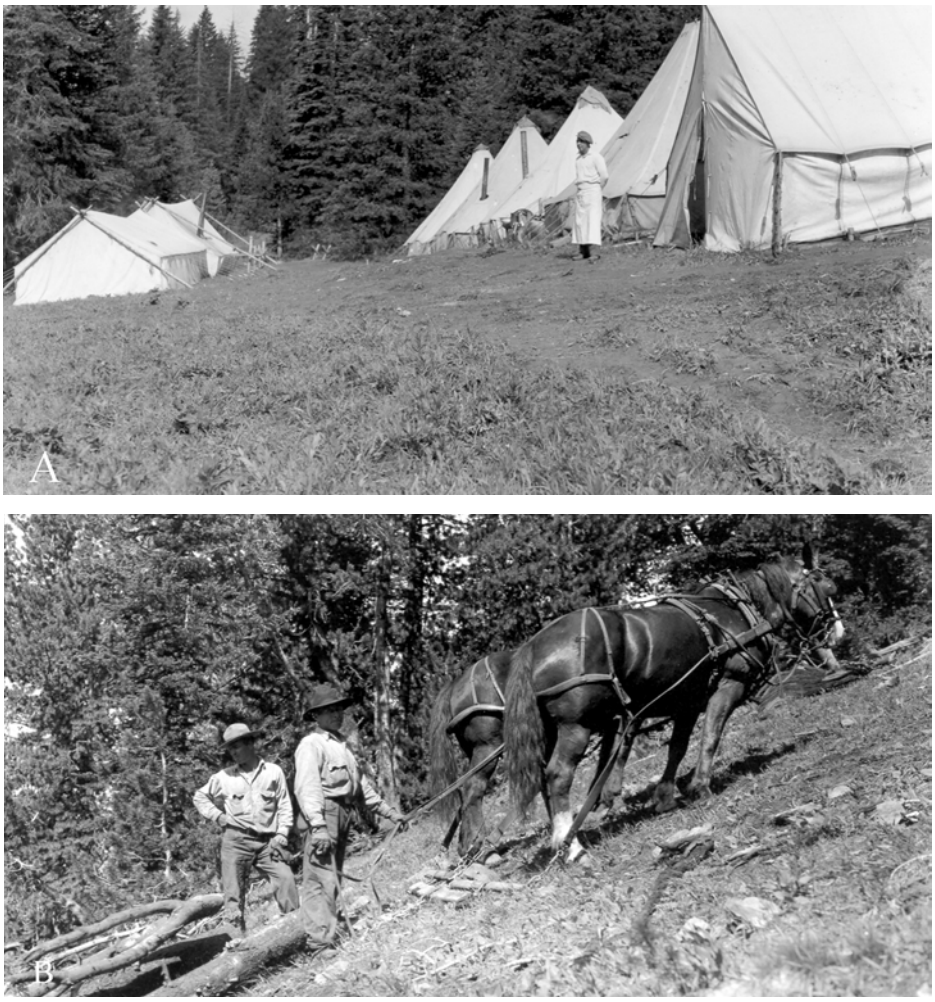

Fig. 15. During 1933 and 1934, efforts were made to control a mountain pine beetle outbreak in whitebark pine on Mt Washburn. (A) Tent camp housing control crews at Dunraven on the mountain. (B) Horses yarding infested stem sections to be piled and burned. (Barrows and Baggley 1934).

The men were divided into "spotting" crews who, guided by a compass-man, mapped and tagged infested trees; and "treating crews of 15 men each [who] followed up the spotting crew and felled, bucked, decked and burned the infested trees." Teams of horses (Fig. 15 B) were used to skid the trees into decks. A total of 2,643 infested trees were treated in this manner.

It was clear that the quality of work by the two sources of labor differed. As noted by Barrows and Bagley in their 1934 report, those hired from nearby towns ". . . soon developed into efficient insect control men . . . It was found, however, that the inexperienced CCC men required considerable supervision and that the short working day caused by travel time to and from [Canyon] camp resulted in costly control."

They concluded:

> The mountain pine beetle epidemic is threatening all of the white bark and lodgepole pine stands in Yellowstone Park. Practically every stand of white bark pine is heavily infested . . . and will be swept clean in a few years. If the insects spread from the white bark pine to the lodgepole stands, it seems inevitable that much of the park will be denuded.

This infestation continued for several more years, and a great majority of susceptible older, large trees succumbed, but white bark pine was not "swept clean." Instead, "Numerous cases were observed where [beetle] attacks had been made on sub-mature trees, but such trees had sufficient vitality to repel attacks by pitching them out" (Elliott 1938).

Mountain pine beetle infestations still persist in the Washburn Range, but whitebark pine communities within the park appear to be secure in their ecological realm in spite of agents such as this beetle and fires. The value of whitebark pine has, however, increased with the more recent recognition of the importance of its seeds as a prehibernation food source of grizzly bears. Concern has now shifted to possible long-term effects of infection by the white pine blister rust, *Cronartium ribicola* Fisch., an exotic fungus that causes widespread and increasing mortality throughout the distribution of this pine species.

The Curtain Closes: Spraying DDT to Control the Spruce Budworm, 1953–1957

In 1947, DDT was applied by airplanes to 400,000 acres of forest to control the Douglas-fir tussock moth in northern Idaho. This was the largest aerial spraying project against a forest insect in the United States to that time (Anon. 1947). Concurrently, vast areas of fir forests in Oregon and Washington were becoming severely defoliated by the western spruce budworm. The successful spraying of the tussock moth in Idaho led to application of DDT to 9 million acres of spruce budworm-infested forests during 1949–1958, mostly in Oregon, Washington, and Idaho, but also including Montana and the northern portion of YNP (Dodge et al 1956, Whiteside and Carolin 1961).

Resurgence of infestation by the spruce budworm in the northern portion of YNP led to spraying 2,000 acres of Douglas-fir in the Lava Creek drainage during1953 (Johnson and Denton 1975). However, the infestation enlarged in 1954, requiring the spraying of 132,800 acres, within (55,412 acres) and outside the park boundary in 1955[4] (Hastings et al. 1961) (Figs. 16, 17). An additional 71,700 acres were sprayed in 1957, including 67,800 acres within the park (Cope 1961). Those projects resulted in spreading 62 tons of DDT and 125,000 gallons of fuel oil over this portion of the park.

Thereafter, use of DDT was discontinued in the park and eventually elsewhere because of mounting evidence of its persistence in the ecosystem and adverse affects on many life forms. The issue was brought forcibly to public attention by the publication of *Silent Spring* (Carson 1962), and the pesticide was banned in the United States in 1972. Even so, DDT was extracted from fish samples taken from Yellowstone River 41 years after the last spraying (Peterson and Boughton 2000), although its origin is speculative.

[4] Personal note: Philip C. Johnson had been on Evenden's staff at Coeur d'Alene, ID, and he headed the laboratory after its relocation to Missoula, MT, early in 1955. He was involved with the budworm control project at Gardner, MT; he recounted that in the evening after a day's work, he and others, including town folk, drove to the nearby dump to watch grizzly bears from YNP foraging there. The dump was closed in 1978 in a program designed to keep bears and humans apart.

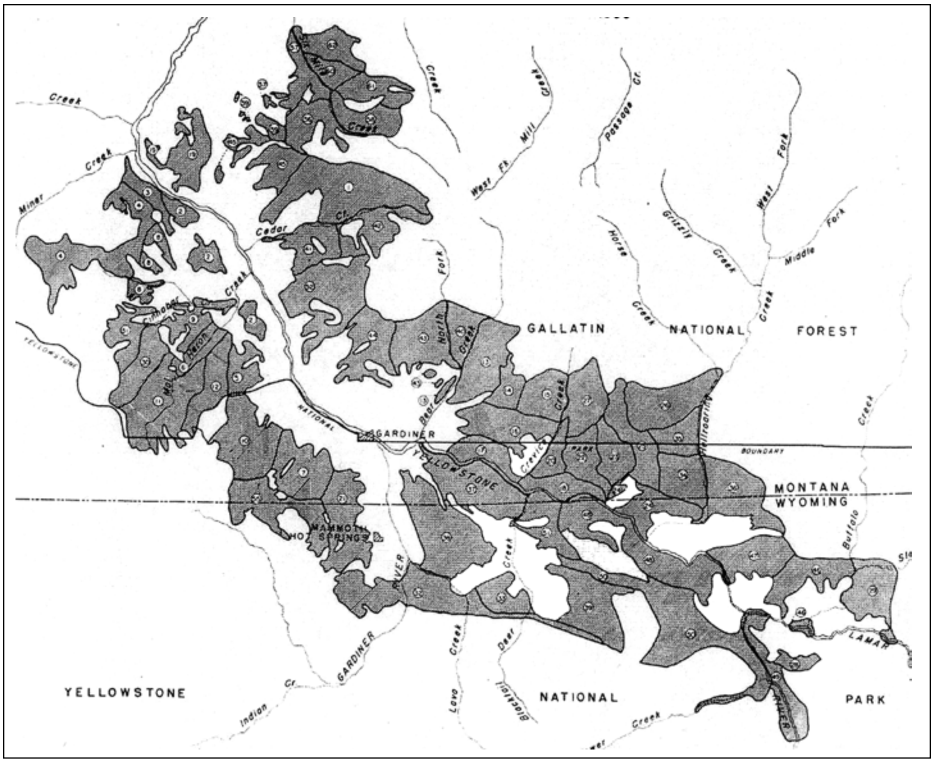

Fig. 16. An oil spray containing DDT was applied by aircraft during 1955–1957 to the northcentral portion of the Park and the surrounding Gallatin National Forest. This map shows the area sprayed during 1955. (Dodge et al. 1956).

Then and Now

Early in the development of YNP resource management, policies were often conflicting or contradictory as viewed today. Park trees even were used on occasion to produce dimension stock for construction within the park. In the preface of the first annual forestry report for YNP (Johnson 1931a), Chief Ranger George Baggley stated: "The timber cutting regulations have been reviewed to afford better management of the timber cutting within the park. Reforestation (planting trees) has been attempted with gratifying results . . . One man [F. T. Johnson, a forestry graduate] has been assigned to give his entire time to the direction of forestry work."

The perceived devastation caused by insects and actions to control them in those early days had the unintentional effect of helping to shape more tolerant attitudes and policies. As knowledge increased about insect–tree relationships, and as park visitation increased, the complexity of managing the park's resources grew. Persons trained in aspects of forestry were needed as much as ever. However, their training has evolved in keeping with this complexity. Now their position title is likely to contain "biologist" and "ecologist" in recognition of the natural and integral part that agents such as insects play in the overall park environment. The evolution of YNP policies regarding forest insects was intertwined with other agents such as fire, tree diseases, wildlife (e.g., bears, elk, and bison), and human activities. Tracking the many circumstances and details involved is beyond our purpose here, but it is treated in some detail by Sellars (1997).

Fig. 17. (A) Loading a Stearman with DDT spray during one of the last spruce budworm control projects in the park, July 1955. (B) Spraying DDT over the western edge of Blacktail Plateau near Lava Creek in YNP. (Photo A, no. 1699; B, no. 392).

We have omitted from this account insects of lesser prominence against which some sort of control action was taken. The spruce beetle, *Dendroctonus rufipennis* (Kirby), and western balsam bark beetle, *Dryocoetes confusus* Swaine, are noteworthy among them. But, even if they and others mentioned herein were included, a listing of Yellowstone's forest insects would be far from complete. Should the diversity of Yellowstone's insects be known in entirety, historical experience indicates that a vast majority are likely benign or beneficial to the park's forests in the long run. If they were otherwise, how could these forests that we extol so much come to be?

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